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IS : 4777 - 1968

*Indian Standard*

PERFORMANCE TESTS FOR PROTECTIVE  
SCHEMES USED IN PROTECTION OF LIGHT  
GAUGE STEEL AGAINST CORROSION

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INDIAN STANDARDS INSTITUTION  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

# Indian Standard

## PERFORMANCE TESTS FOR PROTECTIVE SCHEMES USED IN PROTECTION OF LIGHT GAUGE STEEL AGAINST CORROSION

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NEW DELHI

# *Indian Standard*

## PERFORMANCE TESTS FOR PROTECTIVE SCHEMES USED IN PROTECTION OF LIGHT GAUGE STEEL AGAINST CORROSION

### 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 8 August 1968, after the draft finalized by the Corrosion Protection Sectional Committee had been approved by the Structural and Metals Division Council.

**0.2** With the preparation of the code of practice for the protection of light gauge steel and Indian Standard specifications for various protective schemes, particularly for method of phosphating and also code of practice for phosphate treatment of iron and steel for protection against corrosion, it became necessary that some test methods for performance requirements for protective schemes should also be formulated. The present standard specifies two methods of testing the performance of a protective scheme under corrosive conditions. The first method, known as the Salt Droplet Test, is based on a method of testing with seawater spray devised at the Armament Research Establishment, Ministry of Supply, Government of UK. The second test method is in accordance with IP Standards for petroleum and its products, Part I, Section 2, 153-67T by the Institute of Petroleum, London, which avoids the use of unstable sulphur dioxide solution.

**0.3** The two tests described in the specification are intended to apply mainly to protective schemes for light gauge fabricated steel parts used for permanent building construction and other purposes. They are suitable for testing protective systems applied to bare, phosphated or metal coated steel.

**0.4** Both tests give reasonable correlation with service performance under outdoor atmospheric conditions but they are essentially accelerated corrosion tests and do not reproduce all the factors involved in the natural deterioration of a protective coating.

**0.5** The specification deals mainly with tests on small specimens of steel sheets coated according to the protective scheme or schemes under production conditions. Certain factors cannot be completely reproduced in this way; for example, the local variation in the paint film thickness resulting from drainage, when paint film is applied by dipping, will be

greater for a small specimen and the average film thickness will generally be less than that required for a large article. It is, therefore, an advantage that the salt droplet test can be used to examine the local soundness of the protective scheme on the fabricated parts themselves without causing irreparable damage.

**0.5.1 IP Test** may be used to assess the ability of hard-film and soft-film temporary corrosion preventives to prevent the rusting of ferrous parts. It is applicable to hard-film solvent-deposited, soft-film solvent-deposited, soft-film hot-dipped, and soft-film grease types. The level of corrosion in this test may vary in different runs, but it has been established that a series of protectives may be rated in the same order irrespective of the corrosion losses. The test should, therefore, be considered essentially as a comparative test, for example, for evaluating materials against others of known practical performance.

**0.6** In view of the wide variety of protective schemes and of conditions of exposure in practice, it is better for users of the specification to adopt a minimum test duration to the specified degree of breakdown depending upon their individual requirements.

**0.7** In the formulation of this standard, assistance has been derived from the following publications:

B.S. 1391 : 1952 Performance tests for protective schemes used in the protection of light gauge steel and wrought iron against corrosion. British Standards Institution.

IP Standards for petroleum and its products, Part I, Section 2, 153-67T. The Institute of Petroleum, London.

**0.8** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## 1. SCOPE

**1.1** This standard prescribes two methods of testing the performance of a protective scheme under corrosive conditions to determine whether a desired standard is reached. These tests are:

- a) the salt droplet test, and
- b) the IP test.

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\*Rules for rounding off numerical values ( revised ).

**1.1.1** These tests shall be made on one or more of the following:

- a) Standard test specimens, as defined in Section I, coated by the protective scheme concerned under actual production conditions;
- b) Specimens of the steel, whether metal-coated or not, used for the actual articles, to which the protective scheme has been applied under actual production conditions. These specimens shall be prepared and tested in the same way as the test specimens (see Section I); and
- c) Actual articles. This applies to the salt droplet test only (see 12).

**1.2** An indication of the types of protective schemes to which the tests are most applicable is given in the foreword but no restriction is placed on their use on other types. The use of the tests for any particular purpose and the standard of performance required for such purpose are left to the discretion of those wishing to apply the specification.

**1.3** For certain uses, the ability of a protective scheme to prevent corrosion when in the damaged condition is important. Provision is made, therefore, for the test specimens to be subjected, if desired, to a standard form of damage before they undergo test.

## **SECTION I PREPARATION OF TEST SPECIMENS**

### **2. SPECIMENS**

**2.1** The protective scheme under test shall be applied to rectangular steel panels cut from bright mild steel sheet or strip preferably 0.9 mm thickness, but the use of 1.25 mm material shall be permissible.

**2.2** The steel used for the preparation of standard test specimens shall preferably be cold reduced, full finish, extra deep drawing sheet complying with IS : 513-1963\*. The steel shall have been close annealed 'white to edge', skin passed and finally oiled.

**2.2.1** Alternatively, or, in addition, the sheet used for the production of the actual articles may be used.

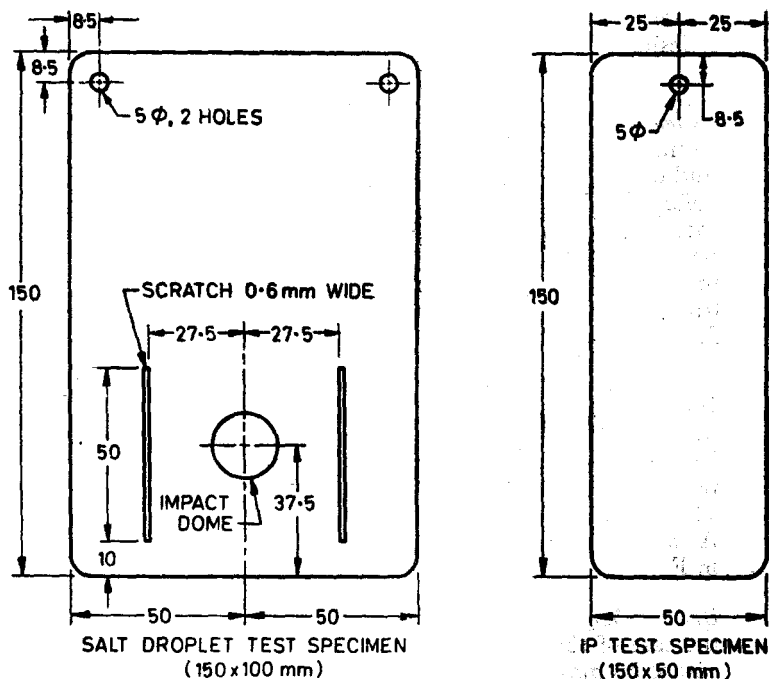
**2.3** For the salt droplet test, the panels shall measure 150 × 100 mm (see Fig. 1). Two holes, 5 mm in diameter and lightly countersunk on each side, shall be drilled at 6 mm distance from each edge near adjacent corners at the ends of a 100-mm side, to enable the specimens to be suspended vertically during the test. All cut edges and corners shall be lightly rounded off and smoothed.

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\*Specification for cold rolled carbon steel sheets (revised).



**2.4** For the IP test, the panels shall measure  $150 \times 50$  mm (see Fig. 1) and shall be provided with a hole, 5 mm in diameter drilled centrally at 6 mm distance from the 50-mm edges. All cut edges and corners shall be lightly rounded off and smoothed.



All dimensions in millimetres.

FIG. 1 STANDARD TEST SPECIMENS (HALF SIZE)

### 3. APPLICATION OF PROTECTIVE SCHEME

**3.1** The preliminary cleaning treatment shall be normally used in production and where the protective scheme includes phosphating or any other surface treatment as a preparation for painting, the same process shall be applied to the panels before painting. Similarly, if a metal coated sheet is used for production, the test panels shall be cut from such sheet.

**3.2** The protective scheme shall be applied to both sides and all edges of the test panels. Where applicable, the method used in actual production shall be employed, for example, where the protective scheme consists of a dipped and stoved paint coating, and a conveyor belt is in operation, the panels shall be suitably mounted on the conveyor. Otherwise, the paint

shall be applied by methods approximating as closely as possible to actual production and yielding the same thickness of paint film.

#### 4. PRELIMINARY DAMAGE

**4.1 Preliminary damage to the protective scheme is optional but, if such damage is desired, it shall be inflicted by either or both of the following methods:**

- a) *By impact* — An impact dome shall be made by means of a single hammer blow, the striker being of steel, hemispherical in shape and of 9.5 mm in radius. The energy of the blow immediately before impact shall be 0.21 kg·m for the standard 0.90 mm specimen (0.23 kg·m for a 1.25-mm specimen) and the blow shall be normal to the surface of the specimen which shall be placed to receive the blow on an anvil as described below. The face from which the dome protrudes shall be defined as the front surface of the specimen.

The standard anvil used in the impact apparatus for 150 × 100 mm specimens shall be radiused tubular section, external diameter 54 mm and internal diameter 40 mm. For 150 × 50 mm specimens the internal diameter of the anvil shall be reduced to 25 mm, the external diameter remaining the same. The anvil is embedded in a cast iron base, 250 × 250 × 45 mm. A sample apparatus for inflicting this damage is illustrated in Fig. 2.

- b) *By Scratching* — Two longitudinal scratches, each 50 mm long in the case of 150 × 100 mm specimens, 40 mm long in the case of 150 × 50 mm specimens and 0.6 mm wide in both cases, shall be made on the lower front surface by means of machine illustrated in Fig. 3. This machine shall normally be used with a load of 1 600 g. In all cases, the scratch shall penetrate the paint film and if necessary the load on the machine shall be increased to ensure this. The scratch may fail to penetrate certain types of metallic coating but this is without detriment to the test. Where it is not possible to use the scratch machine, for example, on an actual article, the scratches may be made by means of a piece of hacksaw blade 0.6 mm thick, and shaped to give a chisel edge.

Damage inflicted as described in (a) and (b) above shall be confined to the lower half of the front face of the specimen. The damage shall be located as shown in Fig. 1. The scratches shall stop at 10 mm from the bottom edge of the specimen; the scratch machine is fitted with a stop to ensure this.

## 5. AGEING PERIODS BEFORE TEST

**5.1** No test shall commence till the specimen is hard dry after the completion of the coating process (*see 3*). If the protective scheme is to be damaged before test (*see 4*), a further interval of at least 24 hours shall elapse between the infliction of the damage and the beginning of exposure. During this interval, the articles shall be kept at room temperature in a clean dry atmosphere.

## 6. BARE STEEL CONTROL SPECIMENS

**6.1** As a check on testing conditions, not less than three bare steel control specimens of the size and material described under **2** shall be included in each batch of test specimens.

**6.2** These control specimens shall be degreased thoroughly. To ensure this they shall first be swabbed with pure carbon tetrachloride, using three changes of swab and solvent. They shall then be degreased in carbon tetrachloride vapour for five minutes or, when this is impracticable, immersed for five minutes in fresh pure carbon tetrachloride and then allowed to drain vertically.

**6.3** The bare steel control specimens shall be weighed after degreasing but shall receive no other treatment. Throughout the test they shall be treated in exactly the same way as the other specimens.

## SECTION II SALT DROPLET TEST

### 7. APPARATUS

**7.1 Atomizer** — Any atomizing nozzle capable of producing fine droplets (not a mist) may be used for the test. A suitable design is illustrated in Fig. 4. The whole atomizer including the container shall be made of non-metallic material, for example, glass or ebonite.

**7.2** Assembly of apparatus required for conducting the salt droplet test is shown in Fig. 5.

### 8. REAGENT

**8.1 Spray Solution** — The spray solution shall be a synthetic sea water, made by dissolving the following salts (of analytical purity) in distilled water:

<i>Salt</i>	<i>Concentration</i> Grams per litre
Sodium chloride, NaCl	23.0
Sodium sulphate, Na <sub>2</sub> SO <sub>4</sub> , 10H <sub>2</sub> O	8.9
Magnesium chloride, MgCl <sub>2</sub> , 6H <sub>2</sub> O	9.8
Calcium chloride (anhydrous), CaCl <sub>2</sub>	1.2

## 9. PROCEDURE

**9.1** The specimens shall be suspended vertically by means of hooks of glass or other non-corrodible insulator passing through the holes in two corners over large dishes partly filled with water. The distance between the surface of the water and the lower edge of the specimens shall be 50 to 75 mm and the specimens shall be one behind the other and all face the same way. They shall be at a convenient distance (not more than 25 mm) apart to prevent touching when being moved and a dummy specimen shall be placed at each end of each row. A suitable arrangement is illustrated in Fig. 5.

**9.2** Once daily, for 5 days a week, all the specimens, including the dummies, shall be removed temporarily from their position on the rack and sprayed individually on both sides with the salt solution (*see 8*), using a hand-operated atomizer (*see 7.1*). The aim shall be to cover the surface with discrete droplets, by giving a number of puffs with the nozzle at a suitable distance (150 to 300 mm) from the specimens, the spray being directed, in turn, at different parts of the surface (*see Fig. 6*). The spraying shall not be so heavy that the droplets coalesce; in order to avoid this it may prove necessary on occasions, where the surface is still wet from the previous spraying to refrain from applying the full weight of spray specified below. It is essential to keep the specimens covered with droplets.

**9.3** Immediately after spraying (*see Note*), the specimens shall be returned to their positions on the rack and the whole collection shall be covered with a box-like cover of sheet metal or other suitable material (Fig. 5), to prevent the drying of the droplets.

**NOTE** — The spray may be absorbed by non-glossy paint films; if so, it may be impossible to check that the desired distribution of droplets (Fig. 6), has been obtained. This difficulty may be overcome by spraying dummy specimens of a material on which the droplets may be seen in such a way as to produce the standard distribution of droplets and then spraying the test specimens in exactly the same way. Steel or glass coated with a hard glossy finish is suitable for this purpose.

**9.3.1** The intensity of spraying may be checked by weighing the solution deposited on both sides of a blank 150 × 100 mm bare steel specimen, freshly degreased as described in 6. The weight of the droplets should lie between 0.5 and 1.0 g.

**9.3.2** The cover shall be suitably designed as to prevent contamination of the specimen.

**9.4** The temperature throughout the test shall preferably be between 25° to 35°C and the test assembly shall be protected against external sources of heat tending to produce local variations in temperature.

## 10. LOSS IN WEIGHT OF CONTROL SPECIMENS

**10.1** At the end of the agreed test period, the loss in weight of the control specimens shall be determined after derusting as described in Appendix A. The average loss in weight shall be not less than the values given in Table 1.

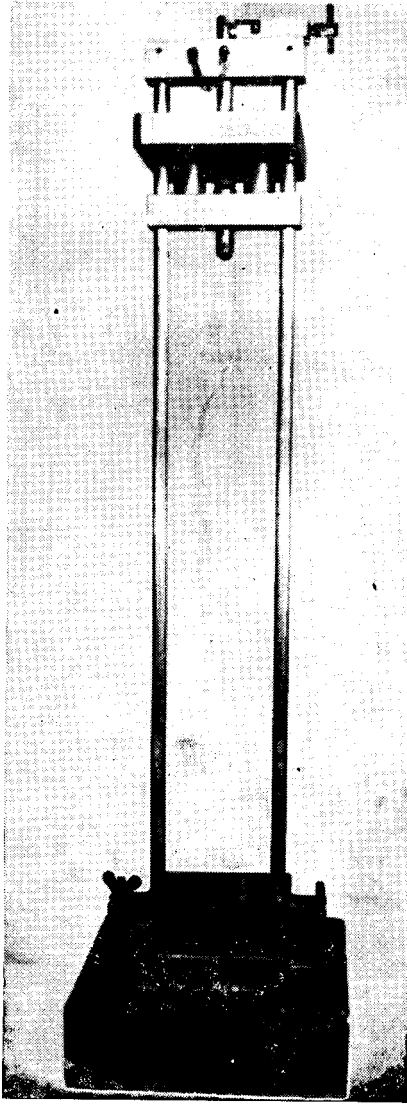


FIG. 2 MACHINE FOR INFLECTING IMPACT DAMAGE

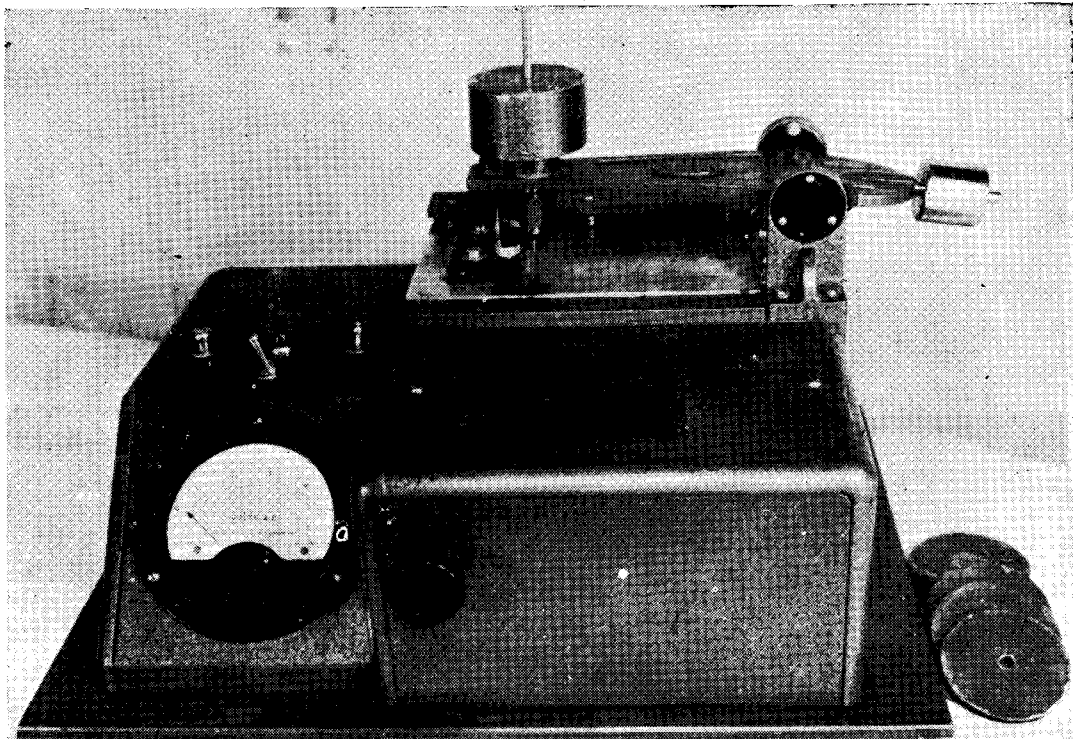


FIG 3 SCRATCH MACHINE

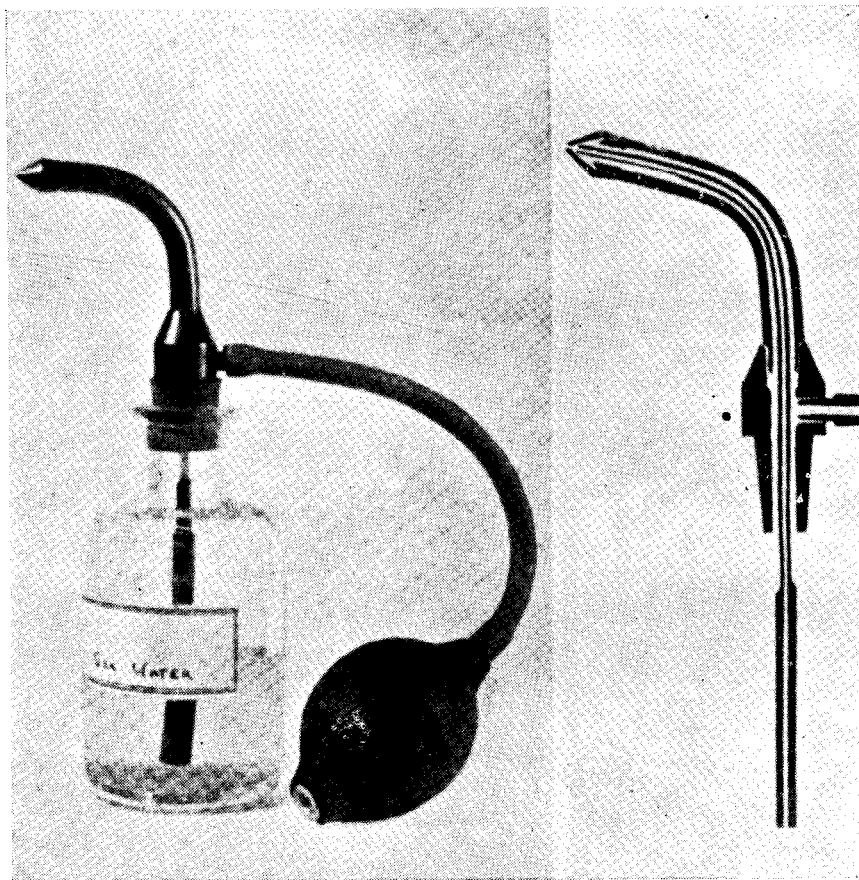


FIG. 4 ATOMIZER

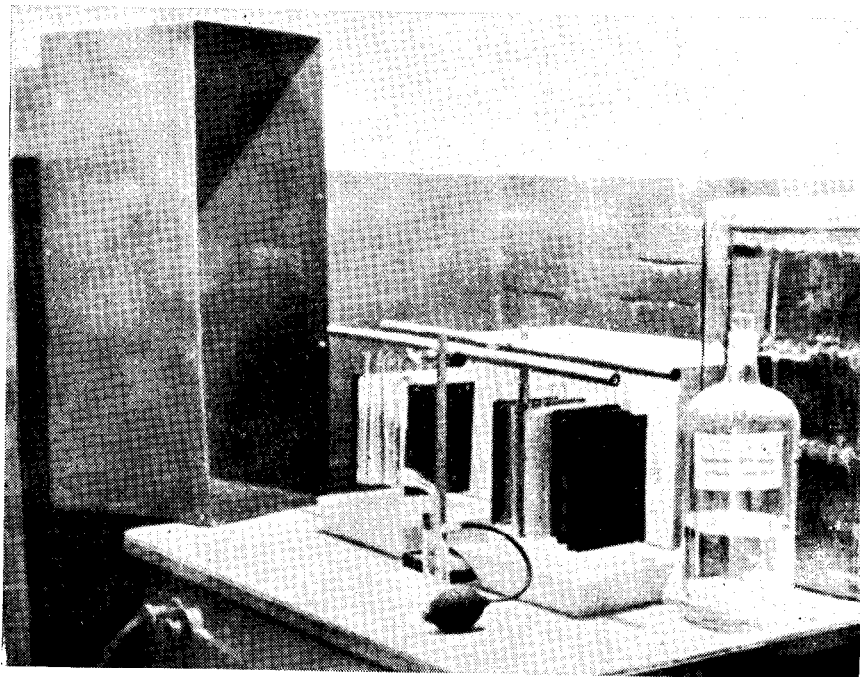
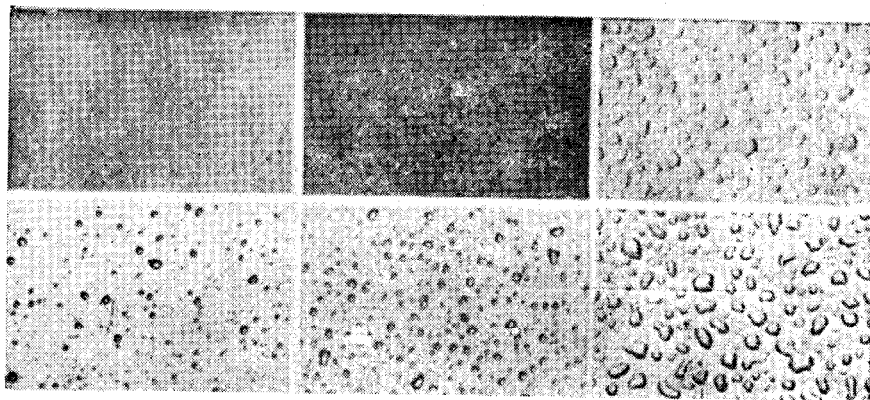


FIG. 5 APPARATUS FOR CONDUCTING SALT DROPLET TEST



Top row. Painted Test Specimens      Bottom row. Uncoated Control Specimens  
 Left. Light Spray ( Too Little )      Right. Heavy Spray ( Too Much )  
 Middle. Medium Spray ( Correct )

FIG. 6 PHOTOGRAPHS TO ILLUSTRATE THE INTENSITY OF SPRAYING  
 REQUIRED ( ACTUAL SIZE )



## 11. INSPECTION

**11.1** At the end of the agreed test period the specimens shall be rinsed in cold water, visually inspected, and allowed to dry at room temperature. Immediately, the specimens are dry, a final inspection shall be made. The same procedure shall be followed if failure is suspected at an earlier stage and if inspection confirms failure, the specimen or specimens concerned may be removed from test.

**TABLE 1 AVERAGE LOSS IN WEIGHT OF SPECIMEN  
BY SALT DROPLET TEST**

( Clause 10.1 )

TEST DURATION	AVERAGE LOSS IN WEIGHT OF SPECIMEN
Days	g
1	0.2
2	0.6
3	1.5
5	3.8
7	4.7

NOTE — Size of test panel is 150×100 mm.

## 12. TEST ON ACTUAL ARTICLES

**12.1** Where size permits, the salt droplet test may be made on actual articles. If it is impracticable to test the whole article, selected areas may be tested *in situ*, the essential feature being that the test area may be enclosed within a cover of glass or other suitable material. The test conditions shall approximate as closely as possible to those, detailed in 9. To prevent complete drying of the sprayed surface, a vessel containing water may be included inside the cover but this is unnecessary if the inside of the cover is lightly sprayed with salt solution at the same time as the specimens. Control of the test temperature between 25° to 35°C is important.

**12.2** If it is desired to damage the protective scheme before test, only the scratch shall be used. This may be inflicted as described in 4 or it may have to be made by hand. There shall be two scratches, each 50 mm long and 0.6 mm wide, parallel and at a distance of 55 mm apart, unless the size or shape of the article does not permit this, in which case alternative arrangements shall be permissible. The article shall be placed for test in such a way that the scratches run vertically, thus eliminating any tendency for rust stain to spread laterally from the scratches under the action of gravity.

**12.3** No test shall commence till the specimen is hard dry after the completion of the coating process and, if the articles are scratched before test an interval of 24 hours shall lapse between the infliction of the scratches and the first spraying. During this interval, the articles shall be kept at room temperature in a clean dry atmosphere.

## SECTION III IP TEST

## 13. APPARATUS

**13.1 Beaker** — of resistance glass, without spout, of 5-litre capacity, approximately 270 mm high and 170 mm outside diameter (Fig. 7) and fitted with a rubber gasket to take the cover.

**13.2 Beaker Cover** — dome-shaped, of unplasticized methyl methacrylate plastic material, kept in position by a suitable rim or groove, and having three 16-mm holes centred along one diameter of the cover, with one at its centre and the other two at 70 mm radius.

**13.3 Thermostat Holder** — a resistance glass test-tube supported in the centre hole of the cover. This test-tube also acts as a support for the panel holder, which is held in place by a stout rubber ring; a piece of rubber tubing, 11-mm bore, 5-mm wall thickness, about 38 mm long, has been found suitable for this purpose.

**13.4 Panel Holder** — of unplasticized methyl methacrylate plastic material capable of supporting twelve panels radially in the beaker. For dimensions (see Fig. 7). Alternative designs are permissible provided the position of the panels is identical.

**13.5 Heater** — electrical, automatically controlled to maintain the specified test temperature, contained in a support that has recess 58 to 64 mm deep in which the beaker sits, the clearance between the beaker and the wall of the recess being approximately 2.5 mm.

NOTE — It has been found that a heater of 150 W, so arranged that 50 W is on continuously and 100 W is controlled by the thermostat described in 13.6, is suitable.

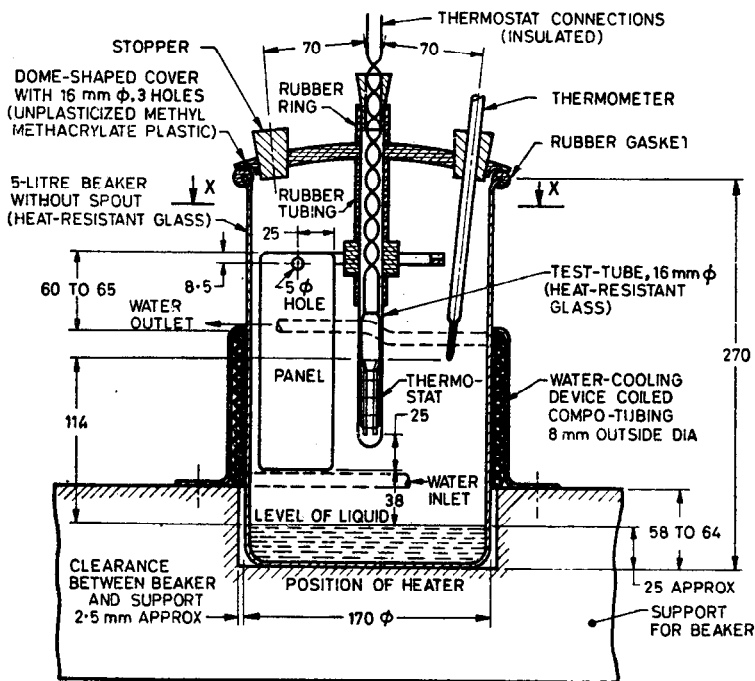
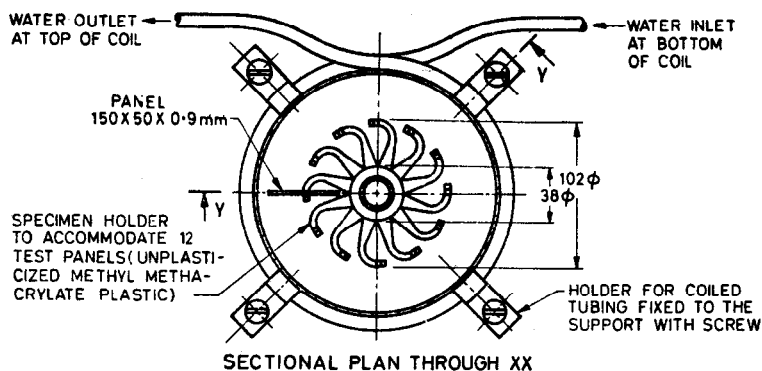
**13.6 Thermostat** — capable of controlling the heater to maintain the temperature of the air space between 42° to 48°C and placed in its holder so that it is 25 mm above the bottom edge of the panels when they are in position (see Fig. 7).

**13.7 Water-Cooling Device** — Coiled compo or similar soft-metal tubing (8 mm diameter) resting on the top of the recess, the number of turns of the coil being such that the top of the coil is 6.0 to 6.5 cm below the level of the top of the panels.

**13.8 Thermometer** — conforming to IS : 4825-1968\* and inserted in one of the holes in the cover so that the bulb is in level with the mid-point of the panels.

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\*Specification for laboratory and reference thermometers (*under print*).



All dimensions in millimetres.

FIG. 7 PANEL HOLDER

## 14. MATERIALS AND REAGENTS

**14.1 Steel Test Panels** —  $150 \times 50 \times 0.9$  mm, thick mild steel conforming to IS : 513-1963\* free from deep pits, scratches, and surface imperfection.

**14.2 Emery Cloth** — grit number 180 conforming to IS : 715-1966†.

**14.3 Sodium Thiosulphate** — solid.  $\text{Na}_2\text{S}_2\text{O}_3$ ,  $5\text{H}_2\text{O}$ .

**14.4 Sulphuric Acid** — 0.15 to 0.16 N.

**14.5 Toluene** — conforming to IS : 537-1967‡.

**14.6 Methanol**

**14.7 Petroleum** — hydrocarbon solvent 60/80 grade (conforming to IS : 1745-1966§). As an alternative, *n*-heptane may be used.

**14.8 Derusting Solution** — concentrated hydrochloric acid containing 5 percent stannous chloride and 2 percent antimony trioxide. (CAUTION: THIS MIXTURE IS TOXIC).

## 15. PROCEDURE

**15.1** Pour into the beaker 500 ml of distilled water in which 50 g of sodium thiosulphate have been dissolved. Assemble the coated panels and two similar prepared, uncoated, weighed panels on the holder. Place the cover on the beaker and adjust the panel holder so that the lower edges of the panels are approximately 40 mm from the surface of the thiosulphate solution. Switch on the current, and run cold water through the cooling coil. When the vapour temperature has stabilized at approximately  $45^\circ\text{C}$ , add 10 ml of sulphuric acid; this corresponds to 0.05 g of sulphur dioxide. Add a further 10 ml of acid after approximately 8 hours and additional 10-ml quantities twice in each working day at intervals of approximately 8 hours, except during the fifth and sixth days. Make these additions from a small graduated cylinder through a long-stemmed funnel to avoid splashing the panels. Except when adding the acid, close the holes in the lid with rubber bungs during the test. Turn each panel through  $180^\circ$  about its vertical axis every 24 hours except on the fifth and sixth days and the whole set of panels through  $90^\circ$  after each addition of the acid. Continue the test for 168 hours.

\*Specification for cold rolled carbon steel sheets (*revised*).

†Specification for coated abrasives, glue bond (*second revision*).

‡Specification for toluene, pure, nitration grade (*first revision*).

§Specification for petroleum hydrocarbon solvents (*first revision*).

15.2 At the end of the test period, remove the panels from the beaker, wash off the corrosion preventive with the petroleum solvent, and derust, with the inhibited hydrochloric acid solution. Keep the panels agitated during the derusting; loosening of rust may be aided by the use of a bristle brush. Use the same procedure for all the panels in any one test. Rinse the panels in cold running water followed by hot distilled water, dry between filter papers, cool in a desiccator, and weigh the panels to the nearest 1 mg.

NOTE — The loss in weight of the blank panels should fall between 2 000 and 3 000 mg for the test to be considered satisfactory.

## 16. LOSS IN WEIGHT OF CONTROL SPECIMENS

16.1 At the end of the agreed test period, the loss in weight of the control specimens shall be determined after derusting as described in Appendix A. The average loss in weight shall be not less than the values given in Table 2.

TABLE 2 AVERAGE LOSS IN WEIGHT OF SPECIMEN BY IP TEST

TEST DURATION Days	AVERAGE LOSS IN WEIGHT OF SPECIMEN g
1	0.5
3	1.3
5	2.0
7	2.2
14	3.6
21	4.1
28	5.8

NOTE — Size of test panel is 150 x 50 mm.

## 17. INSPECTION

17.1 At the end of the agreed test period, the specimens shall be rinsed in cold water, visually inspected, and allowed to dry at room temperature. Immediately, the specimens shall be dried and a final inspection shall be made. The same procedure shall be followed if failure is suspected at an earlier stage. Specimens that have failed shall not be removed from test, unless they are replaced by spare specimens of the same type or types so that the symmetry of the testing conditions is maintained.

## SECTION IV STANDARD OF PERFORMANCE REQUIRED

### 18. NUMBER OF SAMPLES

**18.1** Tests shall be made on three samples of each protective scheme prepared at the same time under identical conditions. In the case of actual articles, however, it is permissible to conduct tests on three different areas of a single article. At the end of the agreed test period, no specimen, article or test area shall fail to comply with the criteria specified in 19.

**18.2** The number of samples or areas tested may be increased by agreement and a portion of them only may be required to pass the test to ensure acceptance of the protective scheme. For example, tests may be made on five samples of which four would be required to pass.

### 19. CRITERIA OF ACCEPTABILITY

**19.1** For acceptance of the protective scheme, the test area of a specimen or article shall satisfy the following conditions at the final inspection made at the end of the agreed test period immediately after the test area has dried:

- a) *Rust and Rust-Staining* — There shall not be more than 0.5 percent (by area) of rust and rust-staining on the undamaged part of the test areas, as defined in 20.

NOTE — Appendix B describes the use of transparent grids for counting rust spots during estimation of the percentage rust and rust-staining for certain protective scheme.

- b) *Spread of Breakdown from Damaged Areas*

- 1) No rust or rust-staining shall extend at any point beyond 5 mm from the original boundaries of the scratches.
- 2) No blistering, lifting or flaking shall extend beyond 1.25 mm from the original boundaries of the scratches.
- 3) No rust, rust-staining, blistering, lifting or flaking shall extend beyond 6.25 mm from the centre of the impact dome. The measurement shall be limited to the spread along a line drawn parallel to the shorter sides of the specimens.

NOTE — The method described in Appendix C may be used to check the adhesion of the protective scheme at and near the dome and scratches.

### 20. TEST AREA

**20.0** The test area for the determination of rust and rust-staining shall be defined as follows.

**20.1 Undamaged Specimens and Articles** — The whole surface of the specimen, article or of the part of the article subjected to test, but excluding any parts lying within 9.5 mm of a cut edge.

**20.1.1** For test specimens separate assessments shall be made on the front and back surface and the protective scheme shall satisfy the criteria of acceptability on both surfaces. For actual articles, acceptance may be based by agreement on the average performance of all surfaces or on the performance of several individual surfaces.

**20.2 Damaged Specimens** — The upper half of the front and back surfaces only, excluding a 9.5-mm band round the cut edges and bounded by an imaginary line 75 mm from and parallel to the top edge.

**20.3 Damaged Articles** — ( No general definition can be given because of the varying sizes and shapes of actual articles. ) The whole of the sprayed surface or surfaces excluding all areas within 9.5 mm of a cut edge and excluding the area surrounding the scratches ( *see* 12 ). The latter area shall be 25 mm wide on each side of the scratch and shall extend from 12.5 mm above the scratch to the bottom edge of the articles when in the test position.

## APPENDIX A

( *Clauses 10.1 and 16.1* )

### DETERMINATION OF LOSS IN WEIGHT OF CONTROL SPECIMENS

#### A-1. REAGENT

**A-1.1 Clarke's Solution** — Dissolve 20 g of antimonious oxide and 50 g of stannous chloride in one litre of hydrochloric acid ( sp gr 1.16 ).

#### A-2. PROCEDURE

**A-2.1** The specimens shall be derusted in Clarke's solution. The solution used shall be cold and the specimens kept moving in it until derusting is complete. The specimens shall then be washed in running water, dried and weighed. The figure to be recorded is the difference between the weight of the freshly degreased specimen and the corresponding weight after derusting.

**A-2.1.1** It is essential that the specimens be kept moving in the solution so as to ensure rapid reduction by the reagent of ferric chloride produced by solution of the rust; otherwise, attack on the steel itself may occur.

## APPENDIX B

[ Note under 19.1(a) ]

## RUST SPOT COUNTING

## B-1. USE OF TRANSPARENT GRIDS

**B-1.1** The estimation of the percentage rust and rust-staining for certain protective schemes may be facilitated by placing a transparent grid ruled into 5 mm squares on the test surface and counting the number of squares in which rust spots occur. For isolated rust spots averaging 1 mm in diameter, the presence of one or more spots in one out of every six squares corresponds to 0.5 percent rusting. The count may be adjusted for cases in which the average size of spot differs from one millimetre. The dimensions of suitable grids are given below:

Size of Specimen	No. of Divisions of Grid ( 5 mm Spacing )		Total Number of Squares
	On Length	On Width	
150 × 100 mm whole surface	25	16	400
150 × 100 mm half surface*	13†	16	200
150 × 50 mm whole surface	25	8	200
150 × 50 mm half surface*	13‡	8	100

**B-1.2** As a rule, rust will be distributed over an appreciable number of spots, as shown in Fig. 8. The occurrence of intense local rusting at one or two places may indicate insufficient care in the preparation and handling of the specimen.

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\*For use when specimen has been damaged before test.

†Two squares from each end of the top two rows omitted.

‡Four squares in centre of top row omitted.



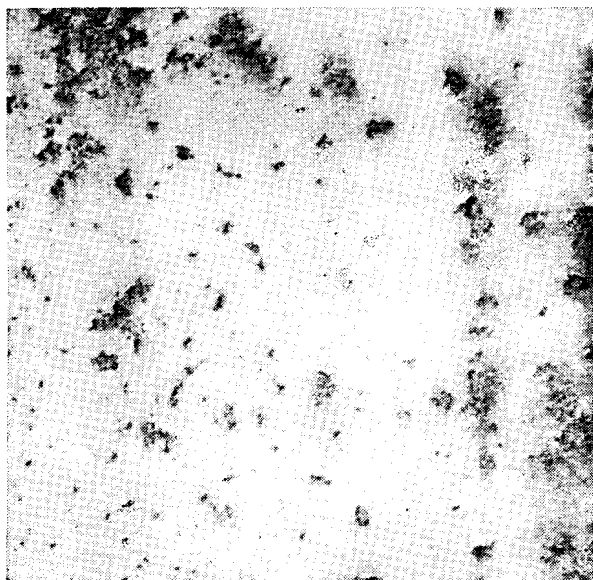


FIG. 8 POINTS OF FAILURE BY GENERAL RUSTING

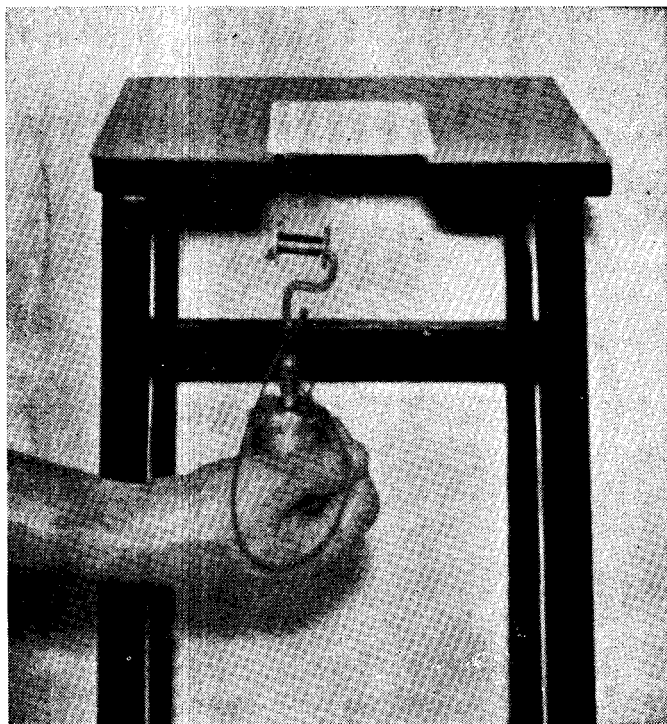


FIG. 9 APPARATUS FOR TAPE TEST FOR ADHESION

## APPENDIX C

[ *Note Under Clause 19.1(b)* ]

### DETERMINATION OF ADHESION OF PAINT COATINGS AT DAMAGED AREAS AFTER TEST

#### C-1. PROCEDURE

**C-1.1** Immediately after the visual inspection at the end of the corrosion test ( *see 11 and 17* ) the specimen is placed in a desiccator over anhydrous calcium chloride and kept there for 2 hours; this is necessary to ensure that paint softened by soaking shall not be removed in addition to paint loosened by corrosion. The specimen is then taken from the desiccator and a length of clear cellulose adhesive tape (pressure-sensitive), 25 mm wide, is applied to the test surface leaving one end free. A length of about 125 mm is needed.

**NOTE** — This test is a useful supplement to visual inspection of the damaged areas but is not to be regarded as a substitute for this.

**C-1.2** The top 75 mm are pressed firmly on to the scratch or impact dome and stroked out with the thumb to ensure complete contact and the exclusion of air bubbles. The specimen is then placed horizontally with the taped face downwards on the support that leaves the taped area and the space for 450 mm below it free of obstruction. The end of the tape is passed round a light tube 40 mm long and about 12.5 mm diameter (Fig. 9). The tape is stuck to itself so as to support the tube and 1 kg weight is tied by means of a string to a hook passing through the tube, leaving a free length of 300 mm of string so that the weight, on release, falls freely through 300 mm before pulling off the tape by a sudden jerk.

**C-1.3** The tape strips may conveniently be mounted for examination on transparent supports and may be kept for record purposes.

**C-1.4** Alternative arrangements are permissible and with suitable modifications. The test may be made on actual articles. It is essential that the tape is pulled off the specimen with a standard jerk of 0.276 kg·m.

**C-1.5** It should be noted that this adhesion test is a more searching test of the spread of damage than visual inspection of the specimen itself so that some relaxation of the criteria of failure listed in 19 may be desirable in the former case. The test may be taken as a useful supplement to visual test but should not be regarded as a substitute for this.

# INTERNATIONAL SYSTEM OF UNITS ( SI UNITS )

## Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

## Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

## Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s <sup>2</sup>
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m <sup>2</sup>
Frequency	hertz	Hz	1 Hz = 1 c/s (s <sup>-1</sup> )
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m <sup>2</sup>

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